

APPENDIX C

CA Tool Specific Proposal Preparation Instructions

C.1 INTRODUCTION

Proposers are expected to provide sufficient details to enable evaluation by persons who are knowledgeable of, but not necessarily specialists in, the proposed technology. Proposals shall be self-contained. That is, no knowledge of technology outside of that described in the proposal should be assumed.

Key areas of the proposal include: (1) a sufficiently detailed description of the proposed CA Tool relative to the technical needs and performance requirements in APPENDIX A; (2) technology maturity information on the proposed CA Tool concept and the proposed approach for substantiating the predicted performance; (3) a description of the proposed activities and their associated cost and schedule; (4) a discussion of the proposed management approach, including the management structure and the system for tracking and reporting progress; and (5) information on the requisite experience and organizational capability for development of the CA Tool.

C.2 DETAILS OF PROPOSAL CONTENTS

All proposals should be assembled with the following parts and in the order listed:

1. Cover page that contains the following information:

Name of this CA Tool TA;

Date of submission;

A proposal title

The legal name and address of the organization and specific division or campus identification, if part of a larger organization;

Point of contact, mailing address, telephone number, FAX number, and e-mail address of the business office person at the technology provider's sponsoring institution;

Proposing technology provider's name and full institutional mailing address, telephone number, FAX number and e-mail address

Technology provider signature and date;

The institutional endorsement, which requires the name and title of the authorizing institutional office, the full legal name of the proposing institution, signature of the authorizing individual, and date;

The designation of the type of proposing institution using the definitions in APPENDIX B; and

Proposed price / costs.

2. Proposal Summary

A statement summarizing the potential capability of the proposed CA Tool concept to satisfy the technology needs and performance requirements described in APPENDIX A.

A brief description of the proposed Corer/Abrader Tool concept that summarizes its central features and predicted performance, and proposed tests of that performance using terminology understandable to a non-specialist, and a concise statement of the proposed approach for demonstrating technology maturity.

Pictorial material for the proposed CA Tool that is suitable for public release

NASA or JPL may publish the proposal title, the Technology Provider's name and institution, summary description, and picture (or drawing). Therefore, the Proposal Summary should not include proprietary information that would preclude its unrestricted release.

3. Table of Contents

4. Technical and Management Section

a. Technical Approach

The most important aspect of the proposal is the capability of the technology concept to meet the needs of NASA future Mars missions specifically including but not limited to the Mars Science Laboratory 2009 Mission as described in APPENDIX A. Accordingly, proposers should fully describe their CA Tool concept activities so that reviewers can assess the potential capabilities/performance of the concept, and the testing of its performance. Therefore, the technical section should include the following:

A detailed description of the proposed CA Tool concept, including;

- Functional block diagram of the proposed Corer/Abrader Tool system concept
- Conceptual layout of Corer/Abrader Tool mechanical components
- Conceptual thermal design
- Conceptual layout of system power, control, electronics, and software
- Estimate of efficiency at lower and higher power levels
- Self-induced vibration sources and control/mitigation approaches
- Preliminary estimate of system lifetime, including identification of the most critical components, and options for increasing life and reliability
- A summary of any exceptions to the APPENDIX A.3, CA General Function Description and Performance Requirements, and the implications of bringing the proposed Tool into compliance.

Expected capability of the proposed technology to benefit multiple future missions;

Description of the current maturity of the proposed technology and the technology maturity level expected. Explain how these determinations were derived;

Discussion of the significant technical challenges to be overcome;

Explanation of the technology development approach including major technical milestones and any special materials, parts or process needed;

Description of how the predicted performance will be substantiated;

Description of proposed activities, deliverables, and their associated cost and schedule.

b. Management Approach

This section shall summarize the management approach and the facilities and equipment required. The management approach should describe essential management functions, and the overall integration of these functions to assure adequate control of the proposed effort within the cost and schedule constraints. This section shall provide insight into the organizations proposed to do the work, including the internal operations and lines of authority, together with internal interfaces and relationships with NASA, any team members, major subcontractors, and associated collaborators. It also identifies the institutional commitment of all team members, and the institutional roles and responsibilities. Proposers shall define the management approach and tools for controlling cost and schedule best suited for their particular teaming arrangement. Proposers should also have a Work Breakdown Structure (WBS) that best fits its organizational approach and technology development capabilities of all team members. The use of innovative processes, techniques, and activities to accomplish their plans is encouraged if cost, schedule, and technical improvements can be demonstrated.

Proposals that include teaming arrangements, partnering and/or contributions to meet the technology development objectives shall specifically address how the proposed team will interrelate internally and with NASA, both organizationally and managerially. The capabilities that each member organization brings to the team, as well as previous experience with similar systems and equipment shall also be addressed.

The management section should include the following:

Approach for managing activities, including the work breakdown structure, a schedule, and the proposed organizational structure;

Identify the roles and responsibilities for each participating organization and key individuals

Approach for securing any proposed technology development collaborations

Assumed funding contributions by technology development collaborations or partnering arrangements with other individuals or organizations not included in the proposed funding;

If applicable, the plan for managing the distribution of responsibilities and arrangements for ensuring a coordinated team effort capable of effectively carrying out the proposed technology development;

Basis and justification for the cost and schedule estimates of this effort;

Expected contribution/commitment by the Technology Provider and his/her parent organization to the proposed technology development effort (include cost and resource sharing, partnering arrangements, etc.);

Technology Provider's historical experience, performance, and institutional capability in the area of technology development and subsequent application.

5. Proposed Personnel. Submit a one-page resume for each of the key personnel who will support the proposed effort (not included in page count).
6. Copy of References. All referenced papers cited in the proposal shall be provided as an attachment to the proposal. For book citations, provide a copy of the relevant pages and the full title of the book and/or an easily understood abbreviation of the publication (e.g., library standard citation or AIAA format) (the copies of reference papers and book references are not included in the proposal page count).
7. Facilities and Equipment. This section should describe any facilities (including any U.S. Government owned facilities) and/or test or experiment equipment that are critical for carrying out the proposal. Discuss the availability of these special facilities and equipment items and any additional equipment or facilities that will be required. Costs shall be included in the proposal Budget Summary. Provide written substantiation (not included in the page count) from the government or other source showing concurrence with the proposed use.
8. Current and Pending Support. Briefly describe any current or planned sources of support that will be contributing to the proposed CA Tool activity. Identify the ongoing and pending projects, sponsoring organization, relevance to the proposed technology, and the resources each organization will contribute or share (not included in page count).

9. Proposed Cost and Schedule. (not included in page count)

- a. Proposed Cost: Provide a one-page cost summary indicating the funding requirements for the Proposal. Provide an explanation of the proposed funding arrangements. Examples include: NASA funds it all; proposer shares costs with NASA; or proposer funds all costs for certain elements.

The Cost Proposal shall be submitted per the requirements of the Corer/Abrader Brassboard Tool Prototype Statement of Work and Delivery Schedule (APPENDIX C.4.a) per the instructions in APPENDIX C.4.b.

- b. Proposed Schedule: Provide a detailed schedule of the proposed activities leading to delivery and demonstration of the Corer/Abrader Tool. Assume the start date given in the CA Tool TA.

C.3 PROPOSAL EVALUATION CRITERIA

Listed below are the criteria and their relative importance for evaluating a Corer/Abrader Tool Brassboard Prototype concept for selection. Within each criterion, factors are of equal importance.

T1 - Technical Merit And Benefits To Future Mars Missions specifically including but not limited to the Mars Science Laboratory 2009 Mission. (40%): Evidence of technical merit, and feasibility of Corer/Abrader Tool concept to meet the needs of future Mars missions and specifically but not limited to meeting the needs of the Mars Science Laboratory 2009 Mission. Factors to be considered are:

- A. Relevance, value, and benefits of the proposed Corer/Abrader Tool concept toward meeting future Mars Mission needs, and specifically but not limited to the Mars Science Laboratory 2009 Mission's needs.
- B. Potential for providing the capabilities, and achieving or exceeding the performance requirements described in the CA Tool TA APPENDIX A.
- C. Degree to which multiple Mars missions can use the proposed technology.

T2 - Technology Maturation (20%): Credibility of the proposed technology development plan and the soundness of the approach for substantiating predicted performance. Factors to be considered are:

- A. Current maturity of the proposed Corer/Abrader Tool Technology and strength of the evidence to show how this maturity has been derived or verified.
- B. Soundness of the proposed technology development approach (i.e., schedule and cost milestones) to assure successful completion of the brassboard prototype.
- C. Adequacy of the testing planned to demonstrate that the hardware and software has attained the required performance.

M1 - Management and Implementation Approach (20%): Thoroughness and credibility of the proposed approach to implementation, including the management structure, schedule realism, level of detail and basis of cost estimate. Factors to be considered are:

- A. Effectiveness of the organizational structure to carry out the proposed management plan for the end-to-end design, development, and testing effort, including identification and availability of key personnel.
- B. Realism and reasonableness of the proposed cost, including contribution assumptions, to complete all design, development, and testing activities.
- C. Realism and reasonableness of the proposed schedule for design, development, and testing activities, and the effectiveness of the system for tracking progress.

M2 - Capabilities of the Provider Organization (20%): Degree to which the technology provider has the requisite experience and organizational capability and commitment to deliver the proposed CA Tool Brassboard Prototype. Factors to be considered are:

- A. Experience of the Technology Provider and organizational capability to test and deliver the CA Tool and software.
- B. Historical performance for technology development and subsequent application.

C. Commitment of the organization's management to the proposed technology development.

C.4 ATTACHMENTS

The following APPENDIX C Attachments include essential information and supplemental instructions for proposal preparation.

- a. Corer/Abrader Tool Brassboard Prototype Statement of Work and Delivery Schedule
- b. CA Tool Cost Information Instructions

ATTACHMENT C.4.a CORER/ABRADER TOOL BRASSBOARD PROTOTYPE STATEMENT OF WORK AND DELIVERY SCHEDULE

STATEMENT OF WORK AND DELIVERY SCHEDULE

1.0 The Subcontractor shall design, fabricate, test, evaluate, report on and deliver a stand-alone Corer/Abrader Tool Brassboard prototype, suitable for a planetary rover, that meets or exceeds the general function description and performance requirements in the Corer/Abrader Tool TA APPENDIX A for the Mars Technology Program. The Subcontractor shall also deliver associated Corer/Abrader Tool test equipment which may include a laptop computer and all operational software to validate its performance. In performance of this effort the Subcontractor shall:

On or Before

1.1 Preliminary Design Phase

Generate and document a Preliminary Design for fabrication of the Corer/Abrader Tool brassboard which meets or exceeds the performance requirements set forth in the Corer/Abrader Tool TA APPENDIX A and which will become Exhibit I of this Contract. This effort shall include the following:

- 1.1.1 Design analysis, tests, component and element tradeoffs necessary to substantiate a recommended design.
- 1.1.2 Participate in bi-weekly status teleconferences referenced in paragraph 1.5.3.3 below.
- 1.1.3 Present the results of the Preliminary Design to JPL for approval at the Preliminary Design Review (PDR). The PDR will be no more than one day review and shall cover the following topics:
 - 1.1.3.1 Preliminary design description, including material and component choices
 - 1.1.3.2 Tradeoff studies leading to the chosen design
 - 1.1.3.3 Any additional information the subcontractor wishes to discuss

1.2 Detailed Design Phase

Upon JPL approval of the preliminary design at PDR, generate and document a detailed design of the Corer/Abrader Tool. The effort shall include the following:

- 1.2.1 Refinement of design, analysis, and tests to determine performance as required.
- 1.2.2 Present the results of the detailed design effort to JPL for approval at the Critical Design Review (CDR) prior

to proceeding with Brassboard prototype fabrication and test. The CDR shall be an all day review and shall cover the following topics:

- 1.2.2.1 Close out all action items from PDR
- 1.2.2.2 Final design description and detailed drawings
- 1.2.2.3 Structural and thermal analysis
- 1.2.2.4 Fabrication techniques, plans, and schedule
- 1.2.2.5 Identify any remaining issues that need to be resolved prior to fabrication
- 1.2.2.6 Any additional information the subcontractor wishes to discuss

1.3 Fabricate, Integrate, Test and Deliver Phase

Fabricate, Integrate, Test and Deliver the following items in accordance with the designs generated in 1.2 above:

- 1.3.1 One (1) Corer/Abrader Tool Brassboard capable of stand alone operation 12 months after date of contract (ADC)
- 1.3.2 Supporting Test Equipment
- 1.3.3 All operational software needed to validate the performance of the Corer/Abrader Tool Brassboard 12 months ADC
12 months ADC

1.4 Document

Prepare and deliver the following documents.

1.4.1 Final Design Package

The Final Design Package shall contain all information necessary to fully specify the design including, but not limited to : a materials and parts list, final as-built drawings, a mass breakdown of all components, interface control document, operating manual, and any specifications used in the manufacture of the Brassboard for the Corer/Abrader Tool

1.4.2 Final Analysis Package

The Final Analysis Package shall contain documents fully describing the structural, vibration, thermal and any other analysis performed on the final design.

1.4.3 Test Results

The Final Test Results Package shall contain documents fully describing the tests performed and the results of those tests. See Exhibit 1, Tables 1 and 2.

1.5 Program Management

- 1.5.1 Provide, upon request, access to the data relating to technical matters directly pertaining to the work being performed under this Contract.

1.5.2 Notify the JPL Subcontract Manager and contract Technical Manger (CTM):

1.5.2.1 At least five working days in advance of technical meetings in which JPL participation would be helpful to the Subcontractor.

1.5.2.2 If a significant problem, such as a schedule slippage, may occur. Work-around plans for these occurrences shall be developed and reviewed with JPL.

1.5.3 Reviews and Meetings in addition to PDR and CDR:

1.5.3.1 Kick-off Meeting:

Within 5 working days of subcontract execution

A kick-off meeting shall be held at the awardees location to discuss plans for the contract. The kick-off meeting shall include presentation of a detailed work schedule that will accommodate the reviews and deliveries within this statement of work.

1.5.3.2 Pre-Ship Teleconference:

This teleconference shall close out any actions generated at the CDR and ensure the Corer/Abrader Tool Brassboard is ready for shipment.

1.5.3.3 Weekly status Teleconferences:

The Subcontractor shall participate in teleconferences every week to discuss management and technical issues. The Subcontractor's Project Manager shall attend, and include anyone pertinent to that meeting's discussions to discuss the Corer/Abrader Tool.

Through end of contract

1.5.4 Financial Status

Provide Financial Status monthly using NASA Form 533M.

15 days after reporting period

1.6 Applicable Documents

The following Exhibits are hereby incorporated into a made a material part of the Contract:

- 1.6.1 Exhibit I, "General Function Description and Performance Requirements," dated April 1, 2004

2.0 Delivery Requirements

- 2.1 Except as otherwise provided in this Subcontract, the point of inspection, acceptance and delivery of all supplies deliverable under this Subcontract shall be the Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, California 91109. All such supplies shall be packaged, packed, boxed, or crated in such a manner to ensure safe delivery and shall be shipped prepaid and at the Subcontractor's expense to the point of delivery.
- 2.2 Time is of the essence in the performance of this Subcontract.

If New Technology is Applicable **DELETE IF NOT**

- 2.2 The Subcontractor shall furnish the cognizant JPL negotiator with the annual and the final reports of reportable items described in Article entitled "New Technology." A copy of transmittal letters for those reports shall also be sent to the Intellectual Property Office (IPO).

If Patent rights is Applicable **DELETE IF NOT**

- 2.3 The Subcontractor shall provide the cognizant JPL Negotiator with the annual and final reports of subject inventions described in the Article entitled "Patent Rights-Retention by the Contractor (Short Form)." A copy of transmittal letters shall be sent to the Intellectual Property Office (IPO).

3.0 JPL will:

- 3.1 Provide review boards for the PDR and CDR
- 3.2 Participate in the review meetings and respond to action items generated at the review meetings and assigned to JPL.
- 3.3 JPL will Review Documentation and respond within ten (10) working days. In the event JPL does not respond in the allotted period, approval will be deemed to be granted.

Mars Technology Program Corer/Abrader Tool Task Specification

1. BACKGROUND / MISSION(S) INFORMATION

Information on future NASA Office of Space Science (OSS) Mars Exploration Missions can be found at the URL: <http://marsprogram.jpl.nasa.gov/missions/>

The overall MSL science objective is to explore and quantitatively assess a local region(s) on the Mars surface as a potential habitat for life, past or present. This mission will use a variety of instruments carried on a rover platform that is expected to remain active for one Mars year.

MSL is envisioned to have a robotic arm (1.5 to 2 m long) that carries tools for abrading to remove outer layer of rock and coring to acquire samples of rock and regolith suitable for scientific evaluation. The corer/abrader tool will be autonomously operated on Mars. It is desired that both of these functions are performed by a single Corer/Abrader tool.

2. GENERAL FUNCTIONAL DESCRIPTION AND PERFORMANCE REQUIREMENTS

The Corer/Abrader is expected to be mounted on a turret, along with other tools and science instruments, at the end of a robotic arm. In order to keep the mass and power requirements of the arm within the estimated capabilities of the rover, the Corer/Abrader must not require excessive force to be applied by the arm to hold it in contact with the rock. The Corer/Abrader must operate over angles from vertical down to horizontal to 45° up, (in other words operate over any angle 0 to 135 degrees with 0 being the corer pointing vertically down) and not require that the arm provide active control during an abrading or coring process. As a result, it is envisioned that the Corer/Abrader has sufficient internal degrees of freedom that, once placed in nominal preloaded contact with a target no further arm actuation is required for the desired abrading or coring action to be accomplished. It is assumed that, if needed, the Corer/Abrader tool will include provisions for starting the coring or abrading without "walking". Shock isolation must be included to limit the shock and vibration environment experienced at the CA/turret interface to the bounds shown in the table below, with margin.

Table 1
Allowable Vibration Spectrum Mounted Instruments at

Frequency	Qualification test Levels
20 – 100 Hz	5.0 g (zero-to-peak)
100 – 2000 Hz	-6 dB / octave
Sweep rate: 1 octave/minute, with 5 repeated up-sweeps	

This tool will have the following performance when drilling rock whose compressive strength ranges up to and including that of hard, dense basalt

Table 2

Parameter	Relationship	Value, units
Diameter of abraded spot	not less than	3.5 cm
Diameter of core	between	0.8 and 1.2 cm
Max Length of core	between	10 and 12 cm
Mass	less than	4 kg
Peak power use (Abrading)	less than	80 Watts
Peak power use (Coring)	less than	80 Watts
Rate of Penetration (abrading)	at least	5mm/hr
Rate of Penetration (coring)	at least	5cm/hr
Average axial preload force (RMS over any 0.1 s)	less than	80 Newtons
Peak 3-axis reaction force to rigid mount	less than	200 Newtons
Average Reaction Torque (RMS over any 0.1 s)	less than	2 Newton-m
Peak 3-axis reaction torque to rigid mount	less than	4 Newton-m
Maximum lateral force (e.g. when starting hole)	less than	15 Newtons
Operational temperature range at mounting I/F	between	-120C and +35C
Operational atmospheric pressure	Between	1000 -6 millibar air and 6 millibar CO2
Lifetime	at least	75 holes 10 cm deep, 75 abrasion sites
Depth of abraded spot	at least	5mm

Abraded surface quality should be adequate for spectral and optical analysis pending instrument selection. The abrader assembly shall provide a brush to clean abrader during operation and to brush dust from surfaces without abrading. In addition to acquiring a solid core (not powdered) as short as 2cm, and capturing long continuous cores from competent rock, this tool will have the ability to break off cores of hard, dense basalt approximately every 2 cm to the full depth of 10 cm. The corer will also have the ability to retain cores or a core tube filled with loose particulate materials (in any orientation), and the ability to eject/release the core or fine material into a sample-handling device.

The delivered brassboard system must be capable of stand-alone operation (e.g. includes a laptop computer and all operational software needed to validate performance per the above table). CA Tool operations shall be demonstrated at the temperatures in the above table under Mars ambient atmospheric pressure (6 millibar, GN2) conditions. Electronics are not required to be tolerant of this environment.

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Dated: April 1, 2004
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Many of the parameters in the above table would be very desirable to improve upon for a flight design - especially mass, preload force, and power (or total time or energy per core). Design options to show how this brassboard would lead to a more optimum flight design may be provided.

The provider will deliver test data with the brassboard instrument showing the performance of the unit in terms of the parameters in the above tables 1 and 2. The unit will be independently evaluated after delivery by mounting it to a 6-axis load cell attached to a rigid fixture connected to a large block of dense basalt, and the parameters of the above tables will be measured in three orientations (horizontal, coring down and coring up at 45°). This test will be repeated with softer aggregate rock, and sample retention in dry, loose well sorted sand.

ATTACHMENT C.4.b CA TOOL COST INFORMATION INSTRUCTIONS

This portion of the proposal instructions outlines the requirements to be followed in submitting cost information. Submit the information requested by the following instructions.

1. DATA SUBMITTAL

Provide a total cost for the Corer/Abrader Tool Statement of Work (APPENDIX C.4.a.) and the applicable supporting data requested below.

a. Price or Cost Breakdown.

- (1) For proposals up to but not exceeding \$550,000.00, provide the information requested on APPENDIX B, Attachment B.7.a item A-19, Cost Elements Breakdown (Short Form). Proposers may provide the requested information, as applicable, on an alternate computer-generated form.
- (2) For proposals greater than \$550,000.00, provide the information requested on APPENDIX B, Attachment B.7.a item A-15, Cost Elements Breakdown. Proposers may provide the requested information, as applicable, on an alternate computer-generated form.

b. Small Start-up Contract

Schedule demands require the issuance of a small start-up subcontract. To facilitate the issuance of such, proposers are required to submit their cost proposal in two parts, one for the startup subcontract which would consist of paragraphs 1.1 Preliminary Design Phase and 1.2 Detailed Design Phase of the CA Statement of Work and Delivery Schedule. The second proposal should cover the remaining CA Statement of Work and Delivery Schedule.

c. Request for Exception

For each item included in the proposal for which the price is based on catalog or market prices, prices set by law or regulation, or is on an active Federal Supply Schedule or other Government Contract, state the basis of the price and provide appropriate reference documentation. If the item is priced at an amount greater than \$550,000.00, a written request for an exception to the submission of certified cost or pricing data in accordance with APPENDIX B, Attachment B.7.a item B-13, "Claims for Exceptions to Cost or Pricing Data," is required.

d. Identify the sources of funding and amounts to be provided by partners.

Note: refer to APPENDIX B.7.a regarding all additional forms and documents required in the proposal